W9132T-05-C-0025

Earthwell Energy Management

Initial Project Description Report:

Demonstration of High Efficiency Combined Heat and Power Natural Gas

Avanti™ PEM Fuel Cell System at Fort Knox Garrison in Kentucky

Proton Exchange Membrane (PEM) Fuel Cell Demonstration Of Domestically Produced PEM Fuel Cells in Military Facilities

US Army Corps of Engineers Engineer Research and Development Center Construction Engineering Research Laboratory Broad Agency Announcement CERL-BAA-FY04

Fort Knox Building 7962, The Anderson Pool Building Fort Knox Army Garrison, Kentucky

March 3, 2005

Executive Summary

This PEM Fuel Cell demonstration project will be installed at Building 7962, The Anderson Pool, Fort Knox Army Garrison in Kentucky. Earthwell Energy Management, Inc. (Earthwell) will provide, install and operate for a period of one year one AvantiTM 5 KW natural gas powered fuel cell combined heat and power system manufactured by Nuvera Fuel Cells, Inc. (Nuvera) of Cambridge, MA.

Earthwell has a long history of working with Fort Knox on energy conservation projects and has had a substantial workforce on the base for the past eight years. Joseph T. Hutchins, Jr., Director of Base Operations Support and Gary Meredith, Energy Coordinator at Fort Knox share Earthwell's enthusiasm for participating in the PEM Fuel Cell Demonstration and agrees with Earthwell that experience and knowledge gained from a fuel cell demonstration compliments the Fort Knox energy managers' desire to pursue cutting edge technologies. Gary Meredith will be the host site contact and can be reached by phone at 502-624-8358, e-mail mereditg@ftknox-emh3.army.mil or mailing address: US Army Armor Center and Fort Knox, Bldg. 1110, Third Floor, Room 311, Fort Knox, KY 40121-5000.

Avanti[™] is a natural gas fueled PEM fuel cell power plant with an integral fuel processor and heat cogeneration that produces 4.6 kW of electrical power and 7 kW of heat. The fuel cell will be grid connected electrically and the co-generated heat will be connected to the swimming pool water heating system. The fuel cell is expected to generate 36,266 kWh of electrical power and 227.883 Mbtu of thermal energy for water heating during the demonstration period. The fuel cell is expected to use 379.6 mcf of natural gas to produce this heat and power with the end result being a net savings of \$640 in costs at current utility rates.

Earthwell will have primary responsibility for the project which includes site assessment, site preparation, installation & restoration, routine operation and maintenance, communications and reporting with the host site and the U.S. Army Engineer Research and Development Center - Construction Engineering Research Laboratory (ERDC-CERL) (project sponsor). Nuvera will provide the AvantiTM system with a combined heat & power (CHP) unit and will provide a one year warranty on both systems. Nuvera will provide training to Earthwell staff at its Cambridge, MA facility. Nuvera will also be responsible for overseeing the AvantiTM installation and supporting Earthwell with the system operation, maintenance and reporting, including any necessary replacement components. It is expected that Nuvera will visit the host site a minimum of four times during this demonstration period. Earthwell will be the primary contractor performing all electrical, data and communications installation. Lusk Mechanical Contractors, Inc. will be a subcontractor to Earthwell for the mechanical installation of the heating system and natural gas installation. Work will be closely coordinated with Fort Knox personnel and Nolin Rural Electric Cooperative, the local Electric utility.

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Proposal – Proton Exchange Membrane (PEM) Fuel Cell Demonstration of Domestically Produced Residential PEM Fuel Cells in Military Facilities

1.0 <u>Descriptive Title</u>

Demonstration of High Efficiency Combined Heat and Power Natural Gas Avanti[™] PEM Fuel Cell System at Fort Knox Garrison in Kentucky, USA.

2.0 Name, Address and Related Company Information

Earthwell Energy Management, Inc.
1300 West Main Street
Louisville, Kentucky 40201
Phone Number – 502-587-8447
Data Universal Numbering System (DUNS) Number - 958165177
Commercial and Government Entity (CAGE) Code – 07RL8
Taxpayer Identification Number (TIN) – 61-1299249

Earthwell Energy Management, Inc. is an energy service company dedicated to delivering value-added energy conservation solutions while enhancing building comfort. As a leader in the energy management field, Earthwell has participated in dozens of energy based performance contracts totaling over \$15 million. Based in Louisville, Kentucky, Earthwell is a licensed electrical contractor in Kentucky, Tennessee, and Ohio. Earthwell currently has twenty-seven (27) full time employees including a licensed professional engineer registered in the State of Kentucky and an electro-mechanical engineer.

3.0 <u>Production Capability of the Manufacturer</u>

Nuvera is the manufacturer of the residential PEM fuel cell to be used in this demonstration. For this program, Nuvera will manufacture the Avanti[™] unit in their Cambridge, MA, USA facility and be responsible for the system for a successful program completion. Nuvera Fuel Cells is located in Cambridge, Massachusetts, USA. Their physical address is:

Nuvera Fuel Cells 20 Acorn Park Drive Cambridge, MA 02140

Nuvera's contact for this program is Mr Prashant S. Chintawar (617 245 7560; pchintawar@nuvera.com).

Nuvera plans to ship 15 AvantiTM systems in calendar year 2005, not including systems built for internal test and development. As of December 31, 2004, Nuvera has completed four AvantiTM Gen3 systems, all of which have been manufactured in the Cambridge, MA facility, where they have capacity to build up to 100 systems per year.

Nuvera will provide the AvantiTM system with a combined heat & power (CHP) unit and integrated fuel processor. Nuvera will provide the required data collection equipment and communications interface. All equipment provided will be warranted for the one year demonstration period. Nuvera will provide training to Earthwell staff at its Cambridge, MA facility for operation and maintenance of the fuel cell and ancillary equipment. Nuvera will also be responsible for overseeing the AvantiTM installation and start up. They will support Earthwell with the system operation, maintenance and reporting, including any necessary replacement components. It is expected that Nuvera will visit the host site a minimum of four times during this demonstration period.

4.0 <u>Principal Investigator(s)</u>

Ronald C. Wyant, CEM, CMVP Project Manager Earthwell Energy Management, Inc. Phone – 502-587-8447 Fax – 502-587-8272 Email – ron.wyant@earthwell.cc

5.0 Authorized Negotiator(s)

Johnny Miller
President
Earthwell Energy Management, Inc.
Phone – 502-587-8447
Fax – 502-587-8272
Email – Johnny miller@earthwell.cc

6.0 <u>Past Relevant Performance Information</u>

Earthwell Energy Management

Earthwell is in the business of high performance buildings – buildings that cost less to own and operate, provide a better working environment, and have less impact on the natural environment. The Earthwell organization is dedicated to and has been delivering performance-based energy enhancement projects for the past ten years which meet our client's desired objectives at the most economical cost, in the shortest amount of time, with little or no interruption, and with the greatest savings.

Every aspect and every employee of our company is focused on delivering value-added services centered on the unique requirements of this complex business. Earthwell has available all the necessary resources, and is uniquely qualified to successfully implement, deliver, and maintain this project.

Earthwell Energy Management is:

- Proud to have completed energy projects for a large number of varied types of projects for local and national customers such as the Commonwealth of Kentucky, Fort Knox Army Base, Jewish Hospital, Louisville International Airport, United States Post Office, Fort Campbell Army Base, The Kroger Company, Proctor and Gamble, and numerous school districts and municipalities.
- An authorized Kohler Power Systems dealer. As a Kohler authorized dealer, Earthwell has
 provided turnkey installation of numerous standby power generation projects. Earthwell
 offers power generation products with services from design assistance through total turnkey
 installation.
- A member of the Energy Services Coalition (ESC). The ESC is a national nonprofit
 organization composed of a network of experts from a wide range of organizations working
 together at the state and local level to increase energy efficiency and building upgrades
 through energy savings performance contracting.

Nuvera

Nuvera has performed extensive work for government and commercial customers:

Table 1: Nuvera Work Experience

Customer	Point of Contact	Contract # / Name	Contract Amount (Net Revenue)	Performance Period
DOE, Office of Energy Efficiency and Renewable Energy	Patrick Davis US DOE 1000 Independence Av SW Washington, DC 20585 (202)586-8061	DE-FC02- 99EE50580 (SFAA)	\$19,854,010 (\$13,245,000)	June 1999 – June 2004
DOE, Office of Energy Efficiency and Renewable Energy	Patrick Davis US DOE 1000 Independence Av SW Washington, DC 20585 (202)586-8061	(PRDA)	\$7,199,000 (\$5,332,000)	
DOE, Office of Energy Efficiency and Renewable Energy	Patrick Davis US DOE 1000 Independence Av SW Washington, DC 20585 (202)586-8061	DE-FC04- 02L67618 (HiQ)	\$17,020,600 (\$12,000,000)	October 2001 – September 2005
National Institute of Standards and Technology	Dr. Gerald P. Ceasar NIST Building 101, Room 226 Gaithersburg, MD 20899 (301) 975-5069	70NANB8H 4072	\$3,470,532 (\$1,735,000)	January 1999 – June 2001
DOE, Office of Energy Efficiency and Renewable Energy	Valri Lightner US DOE 1000 Independence Av SW Washington, DC 20585 (202)586-0937	DE-RP04- 01AL67057 (DOE/E-tek Program)	\$4,296,187 (\$2,787,000)	October 2001 – September 2005
DOE, Office of Energy Efficiency and Renewable Energy	Kathi Epping US DOE 1000 Independence Av SW Washington, DC 20585 (202)586-7425	(DOE/Cater pillar program)	(\$1,062,000)	
DOD, Construction Eng Research Laboratory	Frank Holcomb US Army Corps of Engineers 2902 Newark Drive Champaign, IL 61822 (217)352-6511	DACA42- 02-R-0010	(\$266,000)	August 2003 – June 2005
Mass Technology Collaborative	Jim Christo MTPC 75 North Drive Westborough, MA 01581 (508) 870-0312	Verizon – 5kW stationary demo	(\$1,500,000)	2001-2002

Nuvera's Stationary PEM Fuel Cell Field Demonstrations

Table 2: Nuvera Fuel Cell Demonstrations

Customer (Fuel)	System	kW	Location	Application (Installation)	Achievements
RWE (NG)	Power Stream	5	Meteorit Park, Germany	Residential (turnkey)	Demonstrated grid connected system which supplied power to the park facility
Verizon (NG)	Power Stream	5	Woburn MA, USA	Telecomm- unication (turnkey)	World's first PEMFC telecom demonstration
MIT Lincoln Lab (H2)	H2PM	1X 2	Lexington, MA, USA	Semiconductor Processing (turnkey)	Operated two units for >2,000 hrs, fleet (12 units) collected more than 9000 hours H2PM won Good Design™ award from Chicago Athenaeum museum
DOD CERL (NG)	Avanti [™]	5 X 2	Bristol, RI, USA	Military (turnkey)	Demonstrated high system availability in 2004
Caterpillar (Ethanol)	Model B	10	Pekin, IL, USA	Distributed Generation (turnkey and contractor)	First ethanol PEM FC system demonstration in US
NEF (NG)	Avanti [™]	5	Japan	Distributed Generation (turnkey)	Operation on high sulfur NG
Japan Gas Association (NG)	Avanti™	5	Japan	Distributed Generation (turnkey)	Remote viewer capability

7.0 <u>Host Facility Information</u>

Fort Knox Garrison in Kentucky, USA was chosen as a military base located in the geographic heartland of the United States that offered excellent application opportunities for a residential PEM fuel cell demonstration and whose base operations support staff embraces the use of and development of state of the art technology efficient, environmentally sound energy conserving equipment and methods.

Fort Knox has been a major United States military installation from as early as 1862 when the 6th Infantry constructed fortifications and bridges overlooking the town of West Point, Kentucky. Congress

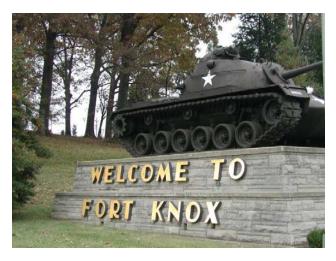


Figure 1: Entrance to Fort Knox

officially designated Fort Knox a permanent Army Garrison on January 16, 1932. Fort Knox Army Garrison now occupies more than 40,000 acres in north western Kentucky and has an average on post population of over 25,000 people.

Fort Knox currently provides a multitude of functions for the United States Army as well as other U.S. military branches and government entities. It serves as a major training center as well as a mobilization center and power support center for Mounted Maneuver Combined Arms Force for Full Spectrum Operations. It also supports many other commands and several U.S. Army Reserve units. The U.S. Treasury Department's United States Bullion Depository is located on post and Fort Know also is home of the Patton Museum of Cavalry and Armor. Fort Knox has an annual procurement budget for services of over \$250 million dollars.

Fort Knox is served by two utility providers.

Providing electricity is: Nolin Rural Electric Cooperative Corporation 411 Ring Road Elizabethtown, KY 42701

And providing electricity and natural gas is:

Louisville Gas & Electric 119 N. Third Street Louisville, KY 40201

The host site contact person is Gary Meredith, Energy Coordinator. His contact information is:

Gary Meredith, Energy Coordinator US Army Armor Center and Fort Knox Bldg. 1110, Third Flr., Rm 311 Fort Knox, KY 40121-5000

Phone: 502-624-8358

e-mail: mereditg@ftknox-emh3.army.mil

8.0 Fuel Cell Site Information

The Anderson Pool, Building 7962, located on Fort Knox Army Garrison is the site chosen for this demonstration. Anderson Pool is operated full time all year and houses an Olympic sized indoor swimming pool, exercise rooms, locker rooms and lobby areas. It is used for aquatics training programs and recreation. It was chosen due to the constant requirement for electrical power for pool filtration and for the constant requirement for heat to maintain the pool water temperature at comfort levels, thus being able to make continuous use of the full outputs of the demonstration fuel cell. The site also offers readily available secure outdoor space adjacent to the building in a location near the electrical service, pool heating system and natural gas supply.



Figure 2: The Anderson Pool, Building 7962

This demonstration will install one 4.6 kW Avanti $^{\text{TM}}$ PEM fuel cell / CHP system as manufactured by Nuvera, at the Anderson Pool Building. There are no known permitting issues involved in siting the fuel cell.

8.1 <u>Site Preparation</u>

The fuel cell will be installed outside of the mechanical room that housed the existing pool heater. Site preparation will include pouring a 6 ft. x 7 ft. concrete pad immediately adjacent to the north wall and west of the double doors to the mechanical room at the North West corner of the building. The concrete pad will provide a surface to mount the fuel cell/CHP system and a safe, level and clean area for servicing the equipment. A six foot high chain link fence will be installed around the concrete pad to prevent unauthorized tampering with the fuel cell. An electronics rack will be installed in existing unused space inside the mechanical room immediately behind the location of the fuel cell to house monitoring communications equipment. secondary heat exchanger and circulation pump for heat recovery will also be located in



Figure 3: Proposed location outside mechanical room

this mechanical room. Penetrations through the north wall of the mechanical room will be required to connect piping for the heat recovery loop, electrical power and communications to the fuel cell. These penetrations will be made low in the wall (within a foot above grade) and will utilize pvc sleeves, which upon decommissioning can be capped for future use or removed and grouted.

8.2 <u>Installation and Commissioning</u>

Installation will include delivery of the equipment, placing equipment in prepared locations and connections to required services. Below is a photograph of the Avanti system planned for installation at Fort Knox.



Figure 4: Avanti [™] Fuel Cell System

8.2.1 <u>Electrical</u>

Electrical connection will be to an existing 208 volt distribution panel located in the pool pump room adjacent to the fuel cell power plant outdoor location. A 208 volt disconnect for electrical isolation of the fuel cell from the existing power distribution will be installed.

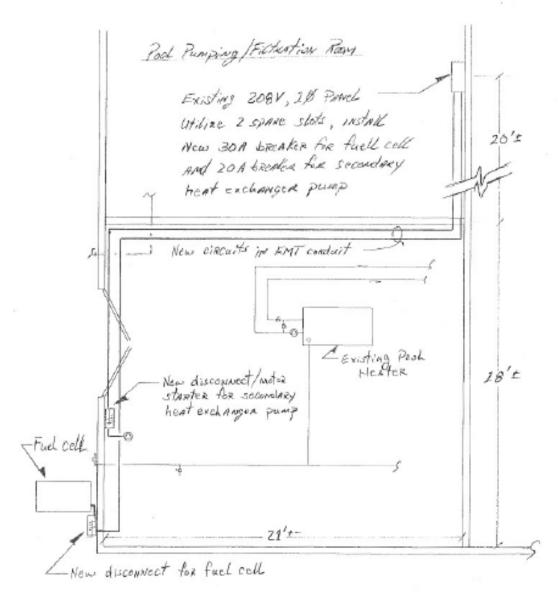


Figure 5: Electrical Installation Anderson Pool

8.2.2 Mechanical

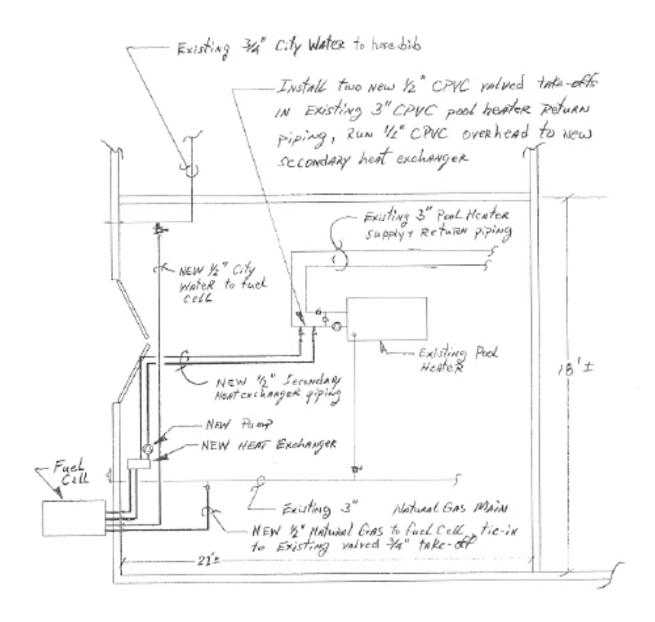


Figure 6: Mechanical Installation Anderson Pool

8.2.3 Fuel

Natural gas is readily available by addition of a line from an existing valve take off from the building gas main that supplies the heating boilers in the mechanical room immediately behind the fuel cell outdoor location.

8.2.4 Water

Feed water is available within the same mechanical room as the natural gas.

8.2.5 <u>Co-generated Heat</u>

Cogeneration system will be connected to the swimming pool water heating system. It will be connected to the cold pool water inlet to the pool water heating boiler to pre-heat that water prior to entering the heater. An additional heat exchanger and circulation pump will be used to isolate treated pool water from the internal fuel cell system.

Earthwell will perform placement of equipment, electrical connections and data connections for monitoring and communications. A dedicated service link (DSL) will be obtained through a local internet service provider to accomplish communications via the internet between the site and all authorized remote locations.

Earthwell will subcontract Lusk Mechanical Contractors, Inc. of Vine Grove, Kentucky to perform the installation of mechanical piping for the co generated heating system and to perform the installation of the natural gas supply for the fuel cell. Earthwell has knowledge and trust in Lusk Mechanical Contractors' ability to provide the required services through many successful projects at Fort Knox that both entities were a party to.

Nuvera personnel will be present to supervise and assist during the installation process. Upon completing installation to the host site's and their satisfaction, Nuvera and Earthwell will start and commission the fuel cell, co generated heating system, monitoring and communications systems.

8.3 Operation and Maintenance

Earthwell employees will be the primary operators for the fuel cell power plant with minimal interaction from site personnel. The automation of the system provides for hands off operation with the occasional reset that may be required after data confirmation or a fault. Earthwell employees will be responsible for the routine maintenance of the system including scheduled maintenance requirements. Nuvera employees will be responsible to direct and/or assist Earthwell at any time non-routine maintenance, diagnosis or trouble shooting is required.

8.4 Monitoring

Two types of data collection will provide monitoring of units. First, the onboard controls of the Avanti $^{\text{TM}}$ unit will monitor the start-stop events with related date and time stamps and total operating hours. From this data the fuel cell's availability and duration of operation can be extracted.

An external data collection unit will record data for the following information: total kilowatt hours (kWh) produced and maximum kW produced will be monitored with an inline electrical power unit, fuel input will monitored by a standard gas meter with signal output, outdoor ambient temperature will be monitored, and thermocouples with a flow meter will record the total heat recovery.

Data from the AvantiTM controls will be recorded in 5 minute (or shorter) intervals and data collected by the external collection system will have an interval of one hour (or shorter).

Additional data will be available from the AvantiTM unit during operation and external sensors will include equipment ambient operating conditions including temperature, humidity and barometric pressure.

This following is a complete specification for AvantiTM. Note two salient features of AvantiTM, very high efficiency and capability to operate on city water.

Avanti[™] - Gen 3 Specifications & Performance

8.5

Table 3: Avanti[™] Specifications and Performance

System Performance	
AC Generation Efficiency ¹	>30% HHV
AC Power Output	2.3 or 4.6 kW (xxx Volts)
AC Rated Nominal	,
Power Output	4.6 kW
AC Output Options	1) 400/230 VAC, 50Hz single phase
•	2) 200 VAC, 50/60Hz 3 wire
	connection
	3) 208 VAC, 60 Hz single phase
CHP Available Thermal	6.9 kW
Energy	
CHP Delivery	65°C
Temperature	
CHP Inlet	5-50°C
Temperature	
Total Efficiency	75%
(electric and thermal)	
Operation Type	Unattended
Operating Modes	1 Continuous
	2 Daily start-stop
	3 Warm
Startup Time (from	120 minutes cold start or
10°C)	30 minutes warm start.
Exhaust Emissions	Less than 10ppm CO, NOx or unburnt
	HC
Routine Maintenance	500 hr
Interval	
Major Component	Stack: 5000 KWh or 6 months.
Lifetime	Fuel processors: 5000 KWh or 6
(whichever comes	months.
first)	
Warranty Balance of	1 year
Plant	
Mechanical and	
Environmental	
Operating	-20°C to 40°C ²
Temperature	

¹ HHV basis, 20°C ambient, sea level, includes all parasitic losses at time of shipment. ² Operation at reduced power allowed above 35°C.

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Table 4: Avanti[™] Specifications and Performance

Dimensions	Width :120cm
	Depth: 56 cm
	Height :140cm Volume : 941 liters
\M/a:abt	
Weight	400 kg
Noise	70 dBA @ 1 m
Location	Indoor / Outdoor
Operating Altitude	-61 to 915m without de-rating and up
	to 1500m with lower efficiency.
Enclosure	weatherproof
	,
External Power	Grid Connection
Fuel and Water	
Requirements	
Fuel	Natural gas
Fuel Consumption at	15.33 kW HHV at maximum output
STP	·
Fuel Supply Pressure	5 to 30 mbar
Required Water	City Water
Quality	
Water Balance	Negative to be drained

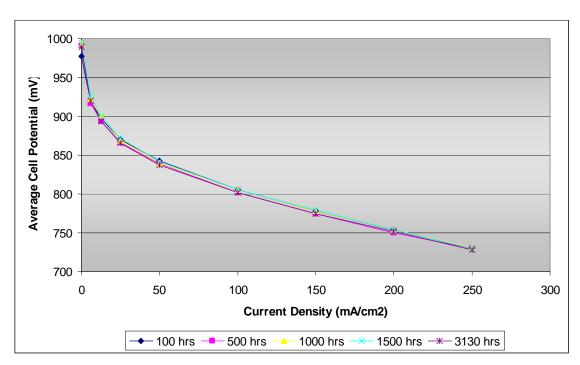


Figure 7: Avanti[™] Fuel Cell Stack Polarization Curve from 0-3100 hrs

9.0 <u>Electrical System</u>

The fuel cell will be installed in a grid connected arrangement. The planned operation will be to operate the fuel cell continuously at full load of 4.6kW utilizing a 208 volt single phase output. Electrical connection to the load, which will be the entire local building electrical load that includes the pool filtration pumps, will be to feed an existing 208 volt distribution panel located in the pool pump room adjacent to the fuel cell power plant outdoor location. A 208 volt disconnect for manual electrical isolation of the fuel cell from the existing power distribution will be installed. Electronic monitoring of the grid power with automatic fuel cell disconnection in the event of grid power failure will be integral to the fuel cell system's D/C to A/C inverter. There will be no external D/C loads.

10.0 Thermal Recovery System

This demonstration will be a combined heat and power system. It will generate 6.9kW of thermal energy when operating at full load. Planned operation is for continuous full load. The thermal recovery system will utilize the heat generated by the fuel cell system to pre-heat swimming pool water as it enters the natural gas fired swimming pool water heater. This will be accomplished by using a secondary heat exchanger external to the fuel cell system to isolate treated pool water from the internal fuel cell system. One closed loop will be between the fuel cell and the secondary heat exchanger and another closed loop will be between the cold pool water inlet to the pool water heating boiler and the secondary heat exchanger. An external circulation pump will be used to circulate the pool water loop and will be controlled from the fuel cell system in parallel with the internal circulation pump.

11.0 <u>Data Acquisition System</u>

Two types of data collection will provide monitoring of units. First, the onboard controls of the Avanti $^{\text{TM}}$ unit will monitor the start-stop events with related date and time stamps and total operating hours. From this data the fuel cell's availability and duration of operation can be extracted.

An external data collection unit will record data for the following information: total kilowatt hours (kWh) produced and maximum kW produced will be monitored with an inline electrical power meter, fuel input will monitored by a standard gas meter with signal output, outdoor ambient temperature will be monitored, and thermocouples with a flow meter will record the total heat recovery.

Data from the AvantiTM controls will be recorded in 5 minute (or shorter) intervals and data collected by the external collection system will have an interval of one hour (or shorter).

Additional data will be available from the AvantiTM unit during operation and external sensors will include equipment ambient operating conditions including temperature, humidity and barometric pressure.

12.0 Economic Analysis

Table 5: Economic Analysis

Fuel Cell at 90% availability for one year =

365 days x 24 hrs/day x .9 = 7,884 hrs

Electrical Output of fuel cell = 4.6kW

Usage reduction = 4.6kW x 7,884 hrs = 36,266.4 kWhrs

Thermal Output of fuel cell = 6.9 kW

6.9kW/hr x 7,884 hrs = 54399.6 kW 54,399.6 kW x 3412 BTU/kW = 185,611,430 BTU = 1,856.11 therms

Assuming existing pool heater is 80% efficient

1,856.11 therms / .80 = 2,320.14 therms

Natural Gas Saved = 2,320.14 therms/yr

Natural Gas

Used = 15.33 kW/hr. x 3,412 BTU/kW x 7,884 hrs./yr.

= 412,380,180 BTU/yr. = 4,123.81 Therms/yr

Net saved gas = $2,320.14 \text{ therms} - 4,123.81 \text{ therms} = \frac{-1,803.67}{1,803.67} \text{ therms}$

Net natural gas costs = $1,803.67 \text{ therms} \times \$0.864 = \$1,558$

Net electrical savings = 36,266.4 kWh x \$0.0538 = \$1,951

Net annual savings = \$ 393

13.0 Kickoff Meeting Information

The kickoff meeting is expected to take place in mid March, 2006. The agenda for the kickoff meeting is expected to be similar to the following:

Demonstration of High Efficiency Combined Heat and Power Natural Gas Avanti[™] PEM Fuel Cell System at Fort Knox Garrison in Kentucky

Kick Off Meeting Agenda

- A) Date, Time and Place of Meeting
- B) Introductions
- Brief description of Fuel Cell Demonstration Program C)
- D) Discussion, Assessment of Project Site
- E) Discussion, Assessment of proposed unit installation
- Discussion, Assessment of electrical interconnections F)
- G) Discussion. Assessment of thermal interconnections
- H) Discussion, Assessment of monitoring equipment and communications
- I) Documentation of required installation modifications, if any
- J) Confirm installation schedule and set start-up date.

14.0 Status/Timeline

The Avanti[™] fuel cell system will be available from Nuvera by mid March, 2006. Below is a table of planned dates for major milestones of the project:

Kickoff Meeting Mid March, 2006 Final Initial Project Description Report

Installation of Avanti[™] Fuel Cell Manufacturers Acceptance Test

Acceptance Meeting

Begin Demonstration (Operation, Monitoring and Analysis)

Begin Monthly Operating Data Reports Midpoint Project Status Report, Draft Final Midpoint Project Status Report End Demonstration, Monthly Reports

Draft Final Report

Fuel Cell removal, Site restoration Final Report, Demonstration Complete

30 days post Kickoff Meeting

April 03, 2006 April 07, 2006 April 10, 2006 April 11, 2006 May, 2006 September, 2006 October, 2006 May, 2007

June, 2007 June, 2007 July, 2007